PROBABILISTIC OUTPUT-ONLY IDENTIFICATION OF SOIL-STRUCTURE SYSTEMS USING SHEAR BEAM MODEL

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This paper proposes a novel probabilistic framework for output-only identification of a soil-structure system. The system is modelled by a vertical shear beam resting on the soil representative springs as shown in Figure 1. The proposed framework estimates the unknown parameters of the system and the foundation input motion time history simultaneously, using sparsely measured responses of the structure. The unknown parameters of the system include stiffness of the sway and rocking springs, shear modulus of the beam, and the modal damping ratios of the system. These parameters are modelled as random variables whose joint probability distribution is updated in a Bayesian scheme using the observations of structural responses.

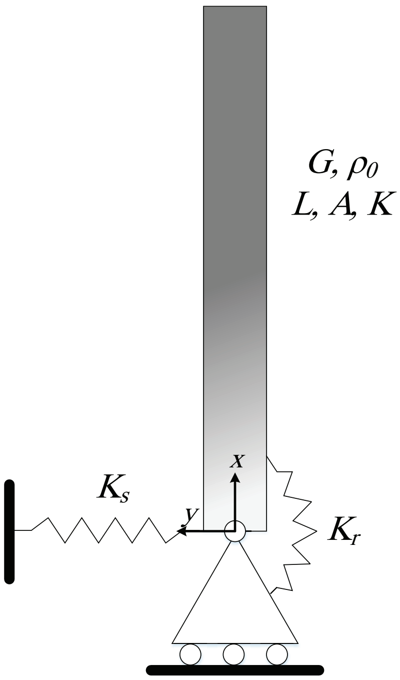

Figure 1. Flexible-base shear beam model.

To this end, extended Kalman filter with unknown-input (EKF-UI) method is employed (Pan et al., 2010). At each time step, an *a priori* estimate of the identification parameters is produced through dynamic equations of the system. Next, the system response is predicted using the *a priori* estimate. Finally, using measured responses of the system, the *a priori* estimates of the identification parameters are updated to produce the *a posteriori* estimates. In fact, this method picks a point between the prediction and measurement as the *a posteriori* estimate such that the sum of the variances of the identification parameters is minimized. This sequence of predication-update procedure is repeated for the next time steps. The results include the mean estimate of the identification parameters and foundation input motion along with an estimate of their uncertainties. Using the continuous shear beam as the representative of the structure leads to a computationally feasible framework for structural health monitoring and damage identification of civil structures at regional scale. Thus, comparing the probability distribution of the stiffness of the system before and after a seismic event facilitates online or semi-online damage detection. The proposed approach is verified through a synthetic example comprising a shear beam resting on sway and rocking representative springs of the soil-foundation system. The simulated absolute acceleration responses of the system to a horizontal seismic excitation are polluted with artificial measurement noise. Then, the noisy responses of the beam are used to identify the unknown parameters and the time history of the ground acceleration. The results show that the parameters of the proposed simplified model are highly identifiable. This holds true even in the presence of high measurement noise and for sparsely instrumented structures.

REFERENCES

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